Observational and Modelling Studies of the California Current Mesoscale

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LONG-TERM GOALS

Our long-term goal is to describe, model, and predict the California Current mesoscale through analysis of observations and through modelling.

OBJECTIVES

Our scientific objectives are to use measurements from the Eastern Boundary Currents (EBC) field experiment and a quasigeostrophic (QG) model to describe and predict the dynamical balances of nonlinear eddies observed in the California Current System (CCS).

APPROACH

The observations consist of currents and temperatures measured in the upper 600 meters in the California Current System on eddy-resolving scales from current meter moorings deployed in three Local Dynamics Arrays (LDAs). Each LDA consisted of five moorings: four moorings forming a square around a central mooring, with instruments located at 100, 150, 300, and 600 meters depth. Mooring separation was about 15 km. These arrays were deployed off of Point Arena, CA. The first array was centered on the continental slope, the second one was in deep water adjacent to the slope LDA, and the third LDA was approximately 400 km offshore. Collaborators on the California Current Moored Array (CCMA) are M. Morris, R. Smith, M. Kosro, S. Ramp, and C. Collins. Additionally, a full ocean depth suite of hydrographic and nutrient measurements were made during the passage of a very strong eddy through the offshore LDA. D. Musgrave (hydrographic measurements) and B. Cornuelle (QG model) have collaborated with us on a detailed modelling study of this eddy, including dynamical balances and a description of its source waters.

WORK COMPLETED

We have two papers in press: an observational study (Chereskin et al., 1999) that presents the key results from the EBC moored arrays and a modelling study (Cornuelle et al., 1999) that is a detailed analysis of the dynamical balances in a nonlinear anticyclone observed at the offshore array (and typical of the anticyclones observed in EBC). A third manuscript (Kosro et al., 1999), a description of the California Undercurrent, is in preparation.

RESULTS

Prior to our measurements, there were no long-term time series in the outer California Current System (CCS) on eddy-resolving scales. Unlike the coastal zone, the outer CCS that we observed was not densely packed with eddies. The offshore mesoscale circulation had a peak at 120- to 180-days, not well resolved by a 2-year time series. The offshore time series were dominated by a few event-like features (strong eddies) and a low-frequency variability that was not well-correlated with the large-scale wind stress curl, leading us to infer the importance of small-scale local wind forcing for the low-frequency background variability. All of the eddies observed at the offshore array were deep, warm, anticyclones, and they were highly nonlinear. Model reconstruction (Cornuelle et al., 1999) of one of these anticyclones that originated in the California Undercurrent suggests a Rossby number of O(1), underestimated by our finite difference calculation (Chereskin et al., 1999). The model results suggest that the anticyclone was a submesoscale coherent vortex. Prior isolated observations have been made of California Undercurrent eddies near the coast. The EBC observations from moorings, surveys, and floats documented numerous occurrences of these Undercurrent eddies in the offshore CCS. We conclude that they are not rare anomalies in the CCS but are ubiquitous.

IMPACT/APPLICATIONS

These results have revised our view of the CCS that formed our hypothesis for the EBC experiment (mesoscale interactions in a weakly nonlinear regime). Rather than viewing the entire CCS as filled with mesoscale eddies, we now have a view of many eddies being formed at the coast, some of which dissipate in place, and some of which propagate west through the CCS to the N. Pacific Ocean. The EBC regime is strongly nonlinear.

TRANSITIONS

The analyzed mooring data have been used by Dr. Bruce Cornuelle in a QG modelling effort supported by NASA. In fact, the transition has been 2-way in that the data provided the initialization and the verification of the model physics for the region, and the QG modelling effort has enhanced our interpretation of the eddy dynamics (Cornuelle et al., 1999).

RELATED PROJECTS

This project is related to an NSF funded project in the NE Pacific: P17N, a WOCE hydrographic/ADCP/tracer transect that sampled past the moored array during the passage of a CUC

eddy. The hydrographic survey supplied nutrient and tracer data which unambiguously identified the water transported by the eddy as being equatorial in origin, transported northward by the California Undercurrent.

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Cornuelle, B. D., Chereskin, T. K., P. P. Niiler, M. Y. Morris, and D. L. Musgrave, 1999: Observations and modelling of a California Undercurrent eddy, *J. Geophys. Res.*, in press.

Kosro, P. M., S. R. Ramp, R. L. Smith, T. K. Chereskin, and P. P. Niiler, 1999: The poleward undercurrent off northern California from time-series measurements over the continental slope, in preparation for Deep Sea Research, Part II.

PUBLICATIONS

Chereskin, T. K., M. Y. Morris, P. P. Niiler, P. M. Kosro, R. L. Smith, S. R. Ramp, C. A. Collins, and D. L. Musgrave, 1999: Spatial and temporal characteristics of the mesoscale circulation of the California Current from eddy-resolving moored and shipboard measurements, *J. Geophys. Res.*, in press..

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The goal of this project was to use observations from the Eastern Boundary Currents (EBC) field experiment and a quasigeostrophic model to describe and predict the dynamical balances of nonlinear eddies observed in the California Current System (CCS). The synoptic, 2-D, quantitative estimates of horizontal shears, vorticity, and divergence resolved by our observations are new, and they have revealed a mesoscale eddy field that is strongly nonlinear, with Rossby numbers of O(1). Model reconstruction of one of the anticyclones confirms the large Rossby number and nonlinearity. The model results suggest that the anticyclones are submesoscale coherent vortices.

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